

# ATTACHMENT 6

**USTA COMMENTS**  
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# **ATTACHMENT D**

**USTA COMMENTS  
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**Attachment D**  
**to Comments of United States Telephone Association**

**Technical Report:**  
**Replication and Update of the X-Factor**  
**Constructed Under FCC Rules**

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## **Executive Summary**

This project replicates and updates the X-Factor model adopted by the FCC in its May 1997 order. An EXCEL spreadsheet is developed duplicating the model presented in Appendix D of the Commission's order. No changes are made to the 1985-95 industry data found in the charts in the FCC order. In those instances where the Commission relied on data produced by the Bureau of Labor Statistics (BLS) or the Bureau of Economic Analysis (BEA), revised data were adopted for the 1985-95 period if and only if BLS and/or BEA revised its data series. In no instance was the Commission's methodology altered. The net effect of the BLS and BEA revisions is modest. The average X-Factor for the post price-cap period 1991-95 period decreases from the FCC's May 1997 reported result of 5.2% to a now updated 5.0%.

The FCC model is updated through 1997. The results for 1996 and 1997 are formed from a framework wholly consistent with that applied to the 1985-95 period. The 1996 and 1997 results are derived using the same formulas applied by the Commission to all earlier years. Industry data for the RBOCs in 1996 and 1997 are provided by USTA and are taken from the same sources identified by the Commission for its 1985-95 data; 1996 and 1997 values of variables based on revised U.S. government data are derived from the same updated data as are their earlier counterparts. Six important conclusions follow from the analysis of the updated data.

- The X-Factors for 1996 and 1997 at 2.1% and 4.1%, respectively, are lower than most of the X-Factors calculated for earlier years. The 2.1% factor for 1996 is the lowest X-Factor since 1986. The 4.1% factor for 1997 is lower than seven of the nine X-Factors over the 1987-95 period.
- The 6.7% factor for 1995, following rising X-Factors in 1993 and 1994, had been interpreted by some as evidence of an upward trend that would continue into the future. It now is evident that the 1995 X-Factor was a short term cyclical peak.
- Comparing the trend in X-Factor averages over the five periods analyzed in the FCC order (1987-95, ..., 1991-95) with the trend in the seven period averages formed from the updated series (1987-97, ..., 1993-97) reveals that both trends are negative. This suggests that a longer term downward trend was in place even before the 1996/97 update.

- Each entry in the latter trend is approximately 0.5 percentage points below its corresponding average ending in 1995.
- No matter which subperiod is selected, no X-Factor exceeds the present 6.5% policy tool (6.0% X + 0.5% CPD).
- Price-cap era averages are consistently below 4.5%.

#### **Summary of Average X-Factor**

1986-97	4.85
1987-97	5.40
1988-97	5.30
1989-97	5.17
1990-97	5.01
1991-97	4.44
1992-97	4.17
1993-97	4.38

**Technical Report:**  
**Replication and Update of the X-Factor**  
**Constructed Under FCC Rules**

The objective of this project is to replicate and update the X-Factor model adopted by the FCC. The Commission presents a technical description of its data sources and model in Appendix D of its May 1997 order. This appendix provides descriptive text, detailed charts, and X-Factor results for the period 1985-95. Using Appendix D as a guide, this project replicates both the data and formulas adopted by the FCC and updates the Commission's results through 1997. This technical report describes the results of this project.

The body of this report is divided into four parts. Section 1 discusses the effort to duplicate the spreadsheet structure of the FCC model. Sections 2 and 3 describe the data sources and steps required to replicate and update the model's industry-specific and economy-wide data series, respectively. Results are reported for sensitivity tests quantifying the effects on the FCC's results of revisions made by the U.S. government to the economy-wide data series. Section 4 discusses the results for 1996 and 1997 relative to those for the 1985-95 period. A complete set of charts presented in exactly the same format as the Commission's 1997 Appendix D charts is attached as Appendix A to this report. The corresponding charts from the May 1997 FCC Appendix D are presented as Appendix B.

It is important to note at the outset that this project focuses narrowly on replicating and updating the FCC model. No evaluation of the FCC approach to measuring productivity is offered or intended. Nothing in this report should be construed as an endorsement of the FCC's methods for measuring either productivity or the X-Factor.

## 1. Model Structure

The combination of text and charts in Appendix D to the Commission's 1997 order provides sufficient information to replicate the FCC model. The text clearly identifies the original data series that are to be gathered from external sources. Explicit formulas are provided in the text describing how these original data series are used to construct intermediate and final variables required by the FCC model.

An EXCEL spreadsheet was constructed mimicking the FCC model. It was tested by initializing it only with the FCC data series that the commission staff used to initialize its model. The spreadsheet successfully produced a set of intermediate and final results for 1985-95 identical to those reported in the FCC appendix.

## 2. Industry Data

Appendix D of the FCC 1997 order identifies the "ARMIS" reports, the Commission's *Statistics of Communications Common Carriers*, and its "Form M" as the primary sources for the industry-specific data series required by its X-Factor model. This project adopts the data set developed by the FCC and presented in Appendix D to its May 1997 order. No independent validation of the FCC data set was conducted.

Updated industry data for 1996 and 1997 were provided by USTA and are presented in Appendix F to this report. Calendar 1995 data also were provided by USTA as a bridge to reconcile each updated data series with the corresponding Appendix D 1985-95 series. The updated series reconciled exactly with the FCC's 1985-95 data with only two exceptions. First, for "switched access minutes" (Chart D4), the 1995 entry in SOCC Table 2.10 is slightly different (less than one percent difference) than the 1995 entry used by the Commission in its 1997 report. To insure consistency with the original FCC study,

switched access minutes for 1996 and 1997 are calculated by applying 1996/95 and 1997/95 growth rates, respectively, from the SOCC report to the 1995 quantity found in the Commission's Appendix D. Second, there is a three-tenths of one percent discrepancy between the Commission's Appendix D level of industry employees in 1995 (Chart D6) and the 1995 employment level reported in SOCC Table 2.9. Following the procedure described above for switched access minutes, updates for 1996 and 1997 are calculated using growth rates. With respect to the 1996 and 1997 data provided by USTA, preliminary estimates are necessary in two instances. First, USTA indicates that updates for 1996 and 1997 "Intrastate DEMs" (Chart D5) are not yet available. Following USTA's recommendation, intrastate DEMs for 1996 and 1997 are projected using the reported value for 1995 and 4.5% growth rates for both 1996 and 1997. Second, ARMIS reporting changes for 1996 labor compensation make it necessary to form an estimate of 1996 RBOC compensation per employee (Chart D6) that maintains consistency with compensation data for earlier and later years. The 1996 estimate is formed by calculating the average annual growth in compensation per employee over the 1995-97 period and applying that growth rate to the 1995 compensation level.<sup>1</sup> The overall result is a complete, consistent set of updated industry data for the 1985-97 period.

### **3. Data Series Taken or Produced from U.S. Government Sources**

There are four data series in the FCC model that are not extracted from industry sources but either are taken directly from or are constructed from data produced by the Bureau of Labor Statistics (BLS) or the Bureau of Economic Analysis (BEA). Two of these series, the input price and total factor productivity (TFP) growth rates for the U.S.

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<sup>1</sup> Because of the way labor and material expenses are defined in the FCC model, replacing the ARMIS labor compensation data for 1996 with the estimate described in the text has exactly offsetting effect on the IPD and TFP differential, leaving the 1996 X-Factor unchanged.



nonfarm business sector, appear, respectively, in columns B and E of Chart D1. The other two are price indexes. The “materials price index” and the “composite asset price” appear in Charts D8 and D9, respectively. Either due to changes in underlying government data or to changes in government methodology, these four data series have undergone revisions since the FCC staff constructed the Appendix D charts for its 1997 order. Each of the revised data series is described separately below. The magnitudes of the revisions in terms of their implications for the input price and TFP differentials and the resulting X-Factors are quantified.

***U.S. Nonfarm Business Sector TFP and Input Prices: BLS Revisions***

The FCC uses the U.S. nonfarm TFP rate as the benchmark for its calculation of the TFP differential. The 1985-95 growth rates reported in column E of Chart D1 in the Commission’s Appendix D correspond to the nonfarm TFP growth rates produced by BLS and reported on page 16 of the BLS News Release, *Multifactor Productivity Trends, 1994* (USDL 95-518). This series was originally produced and currently is maintained and updated by the BLS Office of Productivity and Technology. The BLS updates its TFP series annually. When it does this, it takes the opportunity to incorporate any changes in underlying U.S. data accounts. Revisions therefore occur. The Office of Productivity and Technology was contacted and asked to provide the current nonfarm TFP series consistent with that found in its 1994 release. The most recent series was provided and appears in column E of Chart D1 in Appendix A to this report. Due to BLS revisions, the nonfarm TFP series differs from the corresponding growth rates in the Commission’s original Chart D1 reproduced in Appendix B. (The revised BLS series end in 1996; 1997 estimates will not be available until January 1999. The 1997 growth rate shown in Chart D1 of Appendix A follows the FCC convention of forming an average over TFP growth rates for the preceding five years.)

The BLS Office of Productivity and Technology, as part of its TFP calculation, also produces an input price growth rate for the U.S. nonfarm business sector. The FCC relies on this input price growth rate to calculate its input price differential (IPD). The input price series that existed as of the date the FCC constructed its Appendix D charts appears in column B of Chart D1, Appendix B. The subsequent revision to the BLS nonfarm TFP series led to a similarly revised input price series. This revised series appears in Column B of Chart D1 in Appendix A. Consistent with FCC practice and the estimation of a 1997 TFP growth rate, the 1997 input price growth rate is formed as an average of growth rates over the preceding five years.

The effects of the BLS revisions to its nonfarm TFP and input price growth rates on the IPD, TFP differential, and resulting X-Factors can be seen by comparing columns C, F, and G, respectively, in Chart D1 in Appendix B (the base FCC model) with Chart D1 in Appendix C. The latter chart reflects results for the base FCC model modified only by the BLS revisions to its nonfarm TFP and input price series.<sup>2</sup> Evaluated over a number of years, the BLS revisions lead to a modest reduction in X-Factors. Comparing the average X-Factors in Appendices B and C calculated for the seven subperiods identified at the bottom of Charts D1 shows that, as a result of the BLS revisions, the average X-Factors remain unchanged in two of the subperiods and fall by only one to three-tenths of a percentage point in the remaining five periods. The average X-Factor for the early price-cap period 1991-95 decreases from 5.2% (Appendix B) to 5.0% (Appendix C).

### Materials Price Index: BLS Revisions

The materials price index relied on by the Commission in its Chart D8 also is a function of government data and therefore vulnerable to revision. The methodology the

2 The IPD (column B) remains unchanged in one year, rises between .26 and 1.29 percentage points in four of ten years and falls between -.13 and -1.53 percentage points in five years. The TFP differential increases in the range of .15 to .48 percentage points in seven years; it decreases in the range of -.18 to -.76 percentage points in the other three years. The resulting X-Factor increases by .2 to 1.4 percentage points in four years and falls by -.1 to -1.4 percentage points in six years.

Commission used to construct its materials price index is described in general terms at page D-7 of Appendix D to its May 1997 order. For a detailed methodological discussion, the reader is referenced by a Commission footnote to the "Statement of Dr. John R. Norsworthy" which appeared as part of an AT&T submission to the FCC on January 11, 1996. At page 18 of that statement, Norsworthy makes clear that he constructs his materials price index for the RBOCs using (a) input weights derived from the communications industry column in the BLS 183-order input/output tables and (b) corresponding prices taken from BLS interindustry accounts. The material price index constructed for this project and reported in Chart D8 in Appendix A relies on these same BLS data sources and replicates Norsworthy's methodology.

The resulting materials price index, however, differs from that relied on by the Commission in Appendix D of its May 1997 order. The differences stem from three causes. First, Norsworthy based his materials price index on expenditure shares for the communications industry taken from BLS 183-order input/output tables for 1977, 1987, and 1993. Subsequent to Norsworthy's analysis, BLS revised its input/output tables for these years to make the underlying industry definitions more consistent with Standard Industrial Classification codes. Second, BLS now has available input/output matrices not only for the three years Norsworthy used but also for 1992, 1995, and 2006. Third, BLS revised the price indexes in its interindustry accounts.

Norsworthy's indexing method as described in his 1996 statement is applied to the revised BLS data. Input weights are computed from the revised 183-order input/output tables for 1977, 1987, and 1993 as well as the new tables for 1992, 1995, and 2006 (available at [FTP://146.142.4.23/PUB/SPECIAL.REQUESTS/EP/MACRO.DEMAND.IO/](ftp://146.142.4.23/PUB/SPECIAL.REQUESTS/EP/MACRO.DEMAND.IO/)). Unlike Norsworthy, 1992 weights no longer need to be imputed from 1987 and 1993 weights, and 1993 weights do not need to be held constant for 1994 and 1995. Corresponding prices are taken from the revised interindustry accounts (available at [FTP://146.142.4.23/PUB/SPECIAL.REQUESTS/EP/IND.EMPLOYMNET/IND96.DAT](ftp://146.142.4.23/PUB/SPECIAL.REQUESTS/EP/IND.EMPLOYMNET/IND96.DAT)).

Though these prices are available only through 1996, following the FCC convention, each of the 183-order prices for 1997 is estimated based on its 1996 level and its average growth rate over the preceding five years.

The effect of these BLS revisions on the FCC model can be seen by comparing Charts D1 in Appendix B (the FCC base case) and Appendix D to this report. The latter Chart D1 reflects the FCC base case as originally presented in its May 1997 Appendix D altered only by the substitution of the revised material price index described above. A comparison reveals that the BLS revisions affect the IPD and TFP differential in each year but not the resulting X-Factor. The revised materials price index affects the growth in the RBOCs' input prices and therefore affects the IPD directly. Similarly, since the FCC model also uses the materials price index to deflate RBOC material expenses to define "real" material input, the BLS revisions affect RBOC TFP and therefore the productivity differential. The structure of the FCC model, however, guarantees that the resulting effects on the IPD and TFP differentials are exactly offsetting. The result is that the X-Factors are unaffected.

#### ***Composite Asset Price: BEA Revisions***

The final data series of interest is the BEA composite asset price found in column C of Chart D9. The FCC Appendix D text at page D-8 describes the method the staff used to construct a single asset price index as a function of three BEA asset prices, with asset-specific weights formed from RBOC data for capital additions. For purposes of this project, the indexing formula described on page D-9 of the FCC's descriptive text is applied to data drawn from the same BEA and RBOC sources. Differences in the composite asset prices reported in Appendices A and B (column C, Charts D9) result from BEA revisions to each of the three underlying asset price series as reported in the *Survey of Current Business* tables identified in the FCC text. As was the case for the materials price index, the change in the composite asset price affects the resulting measure of RBOC

capital stock but, given the structure of the FCC productivity model, has an exactly offsetting effect on the price of capital input, also reported in Chart D9. As a result, both the IPD and TFP differentials experience changes, but in exactly offsetting directions. The resulting X-Factors are unchanged. This can be confirmed by comparing Charts D1 in Appendix B (the FCC base case) and Appendix E which reflects the base FCC model amended by the revised BEA composite asset price.

### ***Net Effect of BLS and BEA Revisions***

A net assessment of the effect of all four changes can be made by comparing the IPD, TFP differentials, and X-Factors for the 1985-95 period in Charts D1 in Appendices A and B.<sup>3</sup> The net effect of the changing IPD and TFP differentials on the X-Factors is that it records an increase ranging from .2 to 1.4 percentage points in four years and a decrease ranging from -.1 to -1.4 percentage points in six years. As described above, however, the average X-Factors for the seven subperiods covered in the original FCC Appendix D show little change. The average X-Factors in the seven subperiods either remain unchanged or decline by no more than three-tenths of a percentage point. If one focuses narrowly on the average of the X-Factor over time, the revisions to U.S. government-produced data series have had little impact on the X-Factor.

## **4. 1996 and 1997 Update**

The results for 1996 and 1997 are formed from a framework wholly consistent with that applied to the 1985-95 period. The 1996 and 1997 results reported in Appendix A are derived using the same formulas applied to all earlier years. USTA provided industry data

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<sup>3</sup> Over the ten-year period, the IPD increases in four years, ranging from .07 to 1.02 percentage point increases, and declines in six years with the changes ranging from -.21 to -1.7 percentage points. The TFP

for the RBOCs in 1996 and 1997 taken from the same ARMIS, SOCC, and Form M sources as are the 1985-95 data; 1996 and 1997 values of the four variables based on revised U.S. government data are derived from the same updated data as are their earlier counterparts. However, the resulting X-Factors for 1996 and 1997 at 2.1% and 4.1%, respectively, are lower than most of the X-Factors calculated for earlier years. The 2.1% factor for 1996 is the lowest X-Factor since 1986. The 4.1% factor for 1997 is lower than seven of the nine X-Factors over the 1987-95 period. The 6.7% factor for 1995, following rising X-Factors in 1993 and 1994, had been interpreted by some as evidence of an upward trend that would continue into the future. It now is evident that the 1995 X-Factor was a short term cyclical peak.

Following the convention adopted by the Commission in its May 1997 order, various subperiod averages over the annual X-Factors were calculated and are reported at the bottom of Chart D1 in Appendix A. Three observations are worth emphasizing. The first follows from a comparison of the trend in the X-Factor averages formed over the five periods analyzed in the FCC order (1987-95, ..., 1991-95) with the trend in the seven period averages formed from the updated series (1987-97, ..., 1993-97). The former reflects the original FCC study timeframe and is unaffected by the 1996/97 update. The latter incorporates the effects of the update through 1997. Both trends are negative suggesting that a longer term downward trend was in place even before the 1996/97 update, perhaps signaling that the more easily attainable cost savings following the transition away from full rate regulation have been completed. Second, each entry in the latter trend is approximately 0.5 percentage points below the corresponding average ending in 1995. Third, no matter which subperiod is selected, none exceeds the present 6.5% policy tool ( $6.0\% X + 0.5\% \text{ CPD}$ ). Price-cap era averages are consistently below 4.5%. In short, the updated FCC model offers no support for a continuation of the Commission's current 6.5% X-Factor.

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differential generally increases. It increases in eight of ten years by an amount ranging between .08 and .68 percentage points. It falls in only two years by amounts equaling -.54 and -.75 percentage points.

## APPENDIX A

### UPDATED FCC MODEL

1985-1997

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**Chart D1: Components of FCC LEC Price Cap X-Factor [Excluding CPD]**

Year	Input Price Growth Rates			Total Factor Productivity Growth Rates			LEC
	Total RBOCs	U.S. Nonfarm Business Sector	Differential	Total RBOCs	U.S. Nonfarm Business Sector	Differential	Price/Productivity Differential
	A	B	C=B-A	D	E	F=D-E	G=C+F
1984							
1985							
1986	5.20%	2.33%	-2.87%	2.84%	1.10%	1.74%	-1.13%
1987	0.77%	3.45%	2.68%	3.18%	-0.50%	3.67%	6.36%
1988	-1.31%	5.02%	6.33%	0.39%	0.30%	0.09%	6.42%
1989	-2.35%	2.42%	4.77%	1.95%	0.20%	1.75%	6.52%
1990	1.81%	3.31%	1.50%	6.78%	-0.70%	7.48%	8.99%
1991	-0.75%	1.77%	2.52%	2.13%	-1.41%	3.54%	6.06%
1992	2.74%	3.15%	0.41%	4.38%	1.71%	2.67%	3.08%
1993	2.44%	2.18%	-0.26%	3.97%	0.20%	3.77%	3.51%
1994	-0.11%	3.37%	3.48%	2.29%	0.30%	1.99%	5.47%
1995	1.14%	2.61%	1.48%	5.02%	-0.20%	5.22%	6.70%
1996	5.79%	3.00%	-2.79%	5.79%	0.89%	4.90%	2.11%
1997	0.64%	2.86%	2.22%	2.50%	0.58%	1.92%	4.14%
Averages							
[1986-94]	0.94%	3.00%	2.06%	3.10%	0.13%	2.97%	5.03%
[1986-95]	0.96%	2.96%	2.00%	3.29%	0.10%	3.19%	5.20%
[1987-95]	0.48%	3.03%	2.55%	3.34%	-0.01%	3.36%	5.90%
[1988-95]	0.45%	2.98%	2.53%	3.37%	0.05%	3.32%	5.84%
[1989-95]	0.70%	2.69%	1.98%	3.79%	0.01%	3.78%	5.76%
[1990-95]	1.21%	2.73%	1.52%	4.10%	-0.02%	4.11%	5.63%
[1991-95]	1.09%	2.62%	1.52%	3.56%	0.12%	3.44%	4.96%
[1986-97]	1.33%	2.95%	1.62%	3.44%	0.21%	3.23%	4.85%
[1987-97]	0.98%	3.01%	2.03%	3.49%	0.13%	3.36%	5.40%
[1988-97]	1.00%	2.97%	1.97%	3.52%	0.19%	3.33%	5.30%
[1989-97]	1.26%	2.74%	1.48%	3.87%	0.17%	3.69%	5.17%
[1990-97]	1.71%	2.78%	1.07%	4.11%	0.17%	3.94%	5.01%
[1991-97]	1.70%	2.70%	1.01%	3.73%	0.30%	3.43%	4.44%
[1992-97]	2.11%	2.86%	0.76%	3.99%	0.58%	3.41%	4.17%
[1993-97]	1.98%	2.80%	0.82%	3.92%	0.35%	3.56%	4.38%

Columns B and E for 1997 are estimated, based on the average of 1992-1996.



### Chart D2: RBOC Interstate Revenues

	End User	Interstate Switched Access	Special Access	Total Interstate D = A + B + C
Year	A	B	C	
1984				
1985	\$1,499,413,893	\$10,906,203,190	\$1,960,688,644	\$14,366,305,727
1986	\$2,400,475,814	\$10,484,265,170	\$2,574,800,716	\$15,459,541,700
1987	\$3,090,639,929	\$9,611,996,187	\$2,657,677,439	\$15,360,313,555
1988	\$3,604,221,000	\$9,662,529,000	\$2,539,698,000	\$15,806,448,000
1989	\$4,398,692,000	\$9,092,575,000	\$2,253,922,000	\$15,745,189,000
1990	\$4,679,142,000	\$8,595,750,000	\$2,209,064,000	\$15,483,956,000
1991	\$4,828,177,000	\$8,514,130,000	\$2,119,037,000	\$15,461,344,000
1992	\$4,963,262,000	\$8,650,880,000	\$2,153,565,000	\$15,767,707,000
1993	\$5,244,094,000	\$8,999,065,000	\$2,097,997,000	\$16,341,156,000
1994	\$5,589,662,000	\$9,293,783,000	\$2,217,125,000	\$17,100,570,000
1995	\$5,770,285,000	\$9,332,869,000	\$2,529,667,000	\$17,632,821,000
1996	\$5,930,960,000	\$9,409,639,000	\$3,070,598,000	\$18,411,197,000
1997	\$6,268,026,000	\$8,763,815,000	\$3,851,028,000	\$18,882,869,000

**Chart D3: RBOC REVENUES (Excluding Miscellaneous Services)**

	Local Service	Intrastate Toll and Intrastate Access	Interstate	Total
Year	A	B	C	D = A + B + C
1984				
1985	\$26,960,554,164	\$13,047,095,682	\$14,366,305,727	\$54,373,955,573
1986	\$28,626,174,049	\$13,538,946,795	\$15,459,541,700	\$57,624,662,544
1987	\$29,150,842,991	\$14,166,723,124	\$15,360,313,555	\$58,677,879,670
1988	\$29,226,988,000	\$14,994,975,000	\$15,806,448,000	\$60,028,411,000
1989	\$29,973,157,000	\$14,868,219,000	\$15,745,189,000	\$60,586,565,000
1990	\$30,699,085,000	\$15,014,729,000	\$15,483,956,000	\$61,197,770,000
1991	\$32,059,008,000	\$14,522,276,000	\$15,461,344,000	\$62,042,628,000
1992	\$33,359,990,000	\$14,225,181,000	\$15,767,707,000	\$63,352,878,000
1993	\$34,598,957,000	\$14,496,831,000	\$16,341,156,000	\$65,436,944,000
1994	\$35,758,637,000	\$14,355,983,000	\$17,100,570,000	\$67,215,190,000
1995	\$37,684,860,000	\$13,123,225,000	\$17,632,821,000	\$68,440,906,000
1996	\$40,523,387,000	\$12,987,476,000	\$18,411,197,000	\$71,922,060,000
1997	\$42,460,592,000	\$12,308,613,000	\$18,882,869,000	\$73,652,074,000

Chart D4: Calculation of Fisher Ideal Index for Interstate Output

Year	Revenue Shares			Quantities			Output Indices			Interstate Output Quantity Index	Growth
	End User	Interstate Switched Access	Special Access	Access Lines	Switched Access Minutes	Special Access Lines	Laspeyres A	Paasche B	Fisher Relative $C=(A*B)^{0.5}$		
1984											
1985	10.44%	75.92%	13.65%	92,671,959	156,853,820,000	1,230,590	1.000000	1.000000	1.000000	1.000000	
1986	15.53%	67.82%	16.66%	95,333,884	157,302,701,000	1,664,101	1.053249	1.052253	1.052751	1.052751	5.14%
1987	20.12%	62.58%	17.30%	98,228,585	173,154,171,000	1,764,445	1.083098	1.078813	1.080953	1.137975	7.78%
1988	22.80%	61.13%	16.07%	98,270,787	187,663,836,000	2,701,817	1.144443	1.114960	1.129605	1.285462	12.19%
1989	27.94%	57.75%	14.31%	101,190,050	210,406,134,000	2,448,090	1.065766	1.058920	1.062338	1.365595	6.05%
1990	30.22%	55.51%	14.27%	103,857,988	231,960,296,000	3,518,005	1.129086	1.114500	1.121769	1.531882	11.49%
1991	31.23%	55.07%	13.71%	107,383,807	246,710,182,000	5,151,699	1.111811	1.094856	1.103301	1.690127	9.83%
1992	31.48%	54.86%	13.66%	108,938,065	262,187,655,000	6,033,139	1.062516	1.060258	1.061386	1.793878	5.96%
1993	32.09%	55.07%	12.84%	112,196,681	278,173,161,000	10,153,615	1.136148	1.102619	1.119258	2.007812	11.27%
1994	32.69%	54.35%	12.97%	115,264,861	298,342,017,323	13,824,365	1.095119	1.086800	1.090952	2.190425	8.71%
1995	32.72%	52.93%	14.35%	119,887,506	334,981,582,000	16,107,677	1.101268	1.099925	1.100596	2.410774	9.59%
1996	32.21%	51.11%	16.68%	125,333,996	362,159,903,714	20,775,150	1.099381	1.098687	1.099034	2.649522	9.44%
1997	33.19%	46.41%	20.39%	131,458,355	387,587,696,669	24,479,958	1.081366	1.083163	1.082264	2.867483	7.91%
										Average[1986-95]	8.80%
										Average[1986-97]	8.78%

Chart D5: Calculation of Fisher Ideal Index for Total Company Output

Year	Revenue Shares			Quantities			Output Indices			Total Company Output Index	Growth
	Local Service	Intrastate Toll and Intrastate Access	Interstate	Number of Local Calls	Intrastate DEMs	Interstate Quantity Index	Laspeyres	Paasche	Fisher Relative $C=(A*B)^{0.5}$		
	A	B	C				A	B			
1984											
1985	49.58%	24.00%	26.42%	310,696,999,600	164,191,177,000	1.000000	1.000000	1.000000	1.000000	1.000000	
1986	49.68%	23.50%	26.83%	315,839,746,231	173,173,536,000	1.052751	1.035272	1.034895	1.035083	1.035083	3.45%
1987	49.68%	24.14%	26.18%	320,735,770,416	183,597,411,000	1.137975	1.043561	1.042639	1.043100	1.079696	4.22%
1988	48.69%	24.98%	26.33%	318,724,184,964	191,904,837,000	1.285462	1.041736	1.039449	1.040592	1.123522	3.98%
1989	49.47%	24.54%	25.99%	330,212,044,704	207,298,177,000	1.365595	1.054001	1.053389	1.053695	1.183850	5.23%
1990	50.16%	24.53%	25.30%	342,403,840,684	217,913,904,000	1.531882	1.062478	1.060759	1.061618	1.256797	5.98%
1991	51.67%	23.41%	24.92%	353,219,571,000	219,713,721,000	1.690127	1.044009	1.042832	1.043420	1.311367	4.25%
1992	52.66%	22.45%	24.89%	365,468,629,000	224,278,538,000	1.793878	1.038080	1.038005	1.038042	1.361254	3.73%
1993	52.87%	22.15%	24.97%	376,995,406,000	227,540,869,000	2.007812	1.049556	1.048164	1.048860	1.427765	4.77%
1994	53.20%	21.36%	25.44%	392,601,075,000	235,362,364,000	2.190425	1.052215	1.052028	1.052121	1.502182	5.08%
1995	55.06%	19.17%	25.76%	409,383,799,000	246,926,539,000	2.410774	1.058829	1.058314	1.058572	1.590167	5.69%
1996	56.34%	18.08%	25.60%	422,262,867,000	258,038,233,255	2.649522	1.051485	1.050451	1.050958	1.671199	4.97%
1997	57.65%	16.71%	25.64%	433,086,737,000	269,649,953,751	2.867483	1.043627	1.042853	1.043240	1.743462	4.23%
Average[1986-97]											4.64%
Average[1986-95]											4.63%

The Intrastate DEMs values for 1996 and 1997 are calculated using a 4.5% annual growth rate from the 1995 value.

**Chart D6: Labor Input Price and Growth**

Year	Total Employees A	Total Compensation B	Labor Rate Annual C = B / A	Labor Price Index (Base = 1985)	Labor Growth %Chg in A
1984					
1985	504,113	16,991,572,326	33705.88	1.000000	
1986	482,698	16,728,435,454	34656.11	1.028192	-4.34%
1987	477,714	16,978,905,847	35541.99	1.054474	-1.04%
1988	466,827	17,030,359,791	36481.09	1.082336	-2.31%
1989	461,149	16,910,850,694	36671.12	1.087974	-1.22%
1990	443,105	17,586,868,921	39690.07	1.177541	-3.99%
1991	414,457	17,186,211,200	41466.81	1.230255	-6.68%
1992	411,167	17,160,988,000	41737.27	1.238279	-0.80%
1993	395,639	17,956,438,000	45385.91	1.346528	-3.85%
1994	367,196	17,154,284,000	46716.97	1.386018	-7.46%
1995	346,843	16,203,522,000	46717.17	1.386024	-5.70%
1996	338,040	16,597,889,075	49100.37	1.456730	-2.57%
1997	338,177	17,451,673,000	51605.14	1.531043	0.04%
				Average[1986-95]	-3.74%
				Average[1986-97]	-3.33%

**Chart D7: Summary of Capital Adjustments and Average Depreciation**

Year	TPIS.BOY A	Unadj. Additions B	TPIS.EOY C	Retires D=A+B-C	Adjustment Factor E	Adjusted Additions: F = B * E	Adjusted EOY TPIS G = A+F-D	Depreciation Accruals H	Adjusted Depreciation Rate I=H/((A+G)/2)
1984									
1985	138,879,365	15,001,998	149,061,793	4,819,569	0.8880	13,321,774	147,381,569	10,241,376	7.155%
1986	149,061,793	14,842,725	159,010,189	4,894,328	0.8880	13,180,340	157,347,804	11,826,961	7.720%
1987	159,010,189	14,138,370	167,720,577	5,427,983	0.8880	12,554,872	166,137,079	13,311,655	8.188%
1988	168,505,114	14,284,742	175,860,216	6,929,640	1.0000	14,284,742	175,860,216	13,134,992	7.629%
1989	175,860,216	13,283,569	182,978,381	6,165,404	1.0000	13,283,569	182,978,381	13,420,810	7.480%
1990	182,978,381	14,476,334	187,168,695	10,286,020	1.0000	14,476,334	187,168,695	13,439,933	7.262%
1991	187,168,695	14,527,049	192,034,545	9,661,199	1.0000	14,527,049	192,034,545	13,200,593	6.962%
1992	192,034,545	14,611,866	196,411,915	10,234,496	1.0000	14,611,866	196,411,915	13,337,581	6.867%
1993	196,411,915	14,860,116	203,082,418	8,189,613	1.0000	14,860,116	203,082,418	14,032,782	7.025%
1994	203,082,418	14,717,999	209,325,562	8,474,855	1.0000	14,717,999	209,325,562	14,863,196	7.208%
1995	209,325,562	15,374,568	217,430,207	7,269,923	1.0000	15,374,568	217,430,207	15,358,553	7.198%
1996	217,430,207	18,026,150	227,317,120	8,139,237	1.0000	18,026,150	227,317,120	16,252,281	7.309%
1997	227,317,120	18,253,199	236,896,179	8,674,140	1.0000	18,253,199	236,896,179	16,667,034	7.181%
							Average[1985-95]		7.336%
							Average[1985-97]		7.322%

**A-8**

**A-8**

**A-8**

	USTA Study				FBOC	
	Operating Expense	Nonregulated Expense	Capital/Expense Shift	Shift Factor	Operating Expense	Adjusted Operating Exp.
	A	B	C	D = (A+B+C)/A	E	F = D * E
1985	46,223,368,251	406,886,403	1,985,079,714	1.05175	38,938,104,053	40,953,072,435
1986	48,113,849,487	471,112,072	1,959,363,711	1.05052	40,384,079,165	42,424,084,849
1987	49,562,282,080	1,089,570,002	1,908,791,665	1.06050	41,766,392,483	44,293,127,430

Chart D9: Capital Quantity and Price Index Calculations

	Benchmark	Adjusted Capital Additions	BEA Composite Asset Price	Capital Stock Quantity	Capital Input Quantity	Capital Input Quantity Growth	Property Income /w Depreciation	Capital Rental Price**	Capital Rental Price Index	Rental Price Index Growth
Year	A	B	C	D	E	F	G	H	I	J
1984		n/a		103,903,095						
1985	109,602,959	13,321,774	1.000000	109,602,710	1.000000		23,445,593,794	0.225648857	1.000000	
1986		13,180,340	1.019856	114,486,161	1.054855	0.053403	26,792,578,943	0.244451792	1.083329	8.00%
1987		12,554,872	1.044366	118,109,174	1.101855	0.043592	27,701,751,800	0.241965941	1.072313	-1.02%
1988		14,284,742	1.044248	123,124,340	1.136724	0.031155	26,866,209,000	0.227469282	1.008068	-6.18%
1989		13,283,569	1.062054	126,599,573	1.184992	0.041585	25,845,853,000	0.209916683	0.930281	-8.03%
1990		14,476,334	1.076468	130,760,432	1.218439	0.027834	25,564,541,000	0.202090264	0.895597	-3.80%
1991		14,527,049	1.090143	134,493,889	1.258484	0.032338	24,641,357,000	0.188446586	0.835133	-6.99%
1992		14,611,866	1.099554	137,916,544	1.294417	0.028152	26,477,135,000	0.196864966	0.872440	4.37%
1993		14,860,116	1.094843	141,372,039	1.327357	0.025130	26,914,823,000	0.195152969	0.864853	-0.87%
1994		14,717,999	1.087579	144,534,029	1.380814	0.024746	26,366,385,000	0.186503534	0.826522	-4.53%
1995		15,374,568	1.067533	148,333,219	1.391046	0.022120	27,166,096,000	0.187956401	0.832980	0.78%
1996		18,026,150	1.050090	154,618,035	1.427611	0.025946	30,414,808,000	0.205043807	0.908686	8.70%
1997		18,253,199	1.050090	160,658,026	1.488098	0.041497	30,679,731,000	0.198422719	0.879344	-3.28%



**Chart D10: Factor Shares of Total Payments**

Year	Labor Compensation	Materials Payment	Property Income /w Depreciation	Total Factor Payment	Labor Compensation Share	Materials Payment Share	Property Income /w Depreciation Share
1984							
1985	16,991,572,326	13,936,789,453	23,445,593,794	54,373,955,573	31.25%	25.63%	43.12%
1986	16,728,435,454	14,103,648,147	26,792,578,943	57,624,662,544	29.03%	24.48%	46.49%
1987	16,978,905,847	13,997,222,023	27,701,751,800	58,677,879,670	28.94%	23.85%	47.21%
1988	17,030,359,791	16,131,842,209	26,866,209,000	60,028,411,000	28.37%	26.87%	44.76%
1989	16,910,850,694	17,829,861,306	25,845,853,000	60,586,565,000	27.91%	29.43%	42.66%
1990	17,586,868,921	18,026,360,079	25,584,541,000	61,197,770,000	28.74%	29.46%	41.81%
1991	17,186,211,200	20,215,059,800	24,641,357,000	62,042,628,000	27.70%	32.58%	39.72%
1992	17,160,988,000	19,714,755,000	26,477,135,000	63,352,878,000	27.09%	31.12%	41.79%
1993	17,956,438,000	20,565,683,000	26,914,823,000	65,436,944,000	27.44%	31.43%	41.13%
1994	17,154,284,000	23,694,521,000	26,366,385,000	67,215,190,000	25.52%	35.25%	39.23%
1995	16,203,522,000	25,071,288,000	27,166,096,000	68,440,906,000	23.68%	36.63%	39.69%
1996	16,597,889,075	24,909,362,925	30,414,808,000	71,922,060,000	23.08%	34.63%	42.29%
1997	17,451,673,000	25,520,670,000	30,679,731,000	73,652,074,000	23.69%	34.65%	41.65%

Chart D11: Input Quantity Index

Year	Shares			Quantities			Quantity Indices				Growth
	Labor	Materials	Property	Labor	Materials	Capital	Laspeyres	Paasche	Fisher	Fisher	
	Compensation	Payment	Income /w Depreciation				A	B	Relative C=(A*B)^0.5	Chain	
1984											
1985	31.25%	25.63%	43.12%	504,113	13,936,789,453	1.00000	1.00000	1.00000	1.00000	1.00000	
1986	29.03%	24.48%	46.49%	482,698	13,674,987,526	1.05486	0.96820	0.96822	1.00611	1.00611	0.61%
1987	28.94%	23.85%	47.21%	477,714	13,286,033,126	1.10186	0.98139	0.98140	1.01050	1.01667	1.04%
1988	28.37%	26.87%	44.76%	466,827	14,849,003,149	1.13672	1.04067	1.04083	1.03655	1.05384	3.59%
1989	27.91%	29.43%	42.66%	461,149	15,831,394,231	1.18499	1.02594	1.02654	1.03330	1.08893	3.28%
1990	28.74%	29.46%	41.81%	443,105	15,380,530,820	1.21844	0.96634	0.96623	0.99198	1.08019	-0.81%
1991	27.70%	32.58%	39.72%	414,457	16,776,884,245	1.25848	1.01403	1.01340	1.02147	1.10339	2.12%
1992	27.09%	31.12%	41.79%	411,167	15,965,992,971	1.29442	0.97023	0.97005	0.99353	1.09625	-0.65%
1993	27.44%	31.43%	41.13%	395,639	16,382,401,649	1.32736	0.99637	0.99530	1.00800	1.10502	0.80%
1994	25.52%	35.25%	39.23%	367,196	18,347,418,469	1.36061	1.03052	1.03050	1.02832	1.13631	2.79%
1995	23.68%	36.63%	39.69%	346,843	18,969,381,288	1.39105	0.99639	0.99689	1.00671	1.14394	0.67%
1996	23.08%	34.63%	42.29%	338,040	18,296,870,339	1.42761	0.96850	0.96855	0.99180	1.13455	-0.82%
1997	23.69%	34.65%	41.65%	338,177	18,287,867,671	1.48810	0.99987	0.99987	1.01749	1.15440	1.73%

Chart D12: Input Price Index

Year	Shares			Prices			Price Indices				Growth
	Labor	Materials	Property	Labor	Materials	Capital	Laspeyres	Paasche	Fisher	Fisher	
	Compensation	Payment	Income /w Depreciation				A	B	Relative C=(A*B)^0.5	Chain	
1984											
1985	31.25%	25.63%	43.12%	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	
1986	29.03%	24.48%	46.49%	1.02819	1.03135	1.08333	1.06395	1.06482	1.05335	1.05335	5.20%
1987	28.94%	23.85%	47.21%	1.05447	1.05353	1.07231	1.00076	1.00024	1.00770	1.06146	0.77%
1988	28.37%	26.87%	44.76%	1.08234	1.08639	1.00807	0.97067	0.97232	0.98694	1.04759	-1.31%
1989	27.91%	29.43%	42.66%	1.08797	1.12623	0.93028	0.96555	0.96615	0.97677	1.02326	-2.35%
1990	28.74%	29.46%	41.81%	1.17754	1.17202	0.89560	0.99454	0.99347	1.01826	1.04194	1.81%
1991	27.70%	32.58%	39.72%	1.23025	1.20494	0.83513	0.97200	0.97327	0.99249	1.03412	-0.75%
1992	27.09%	31.12%	41.79%	1.23828	1.23480	0.87244	1.03571	1.03609	1.02777	1.06283	2.74%
1993	27.44%	31.43%	41.13%	1.34653	1.25535	0.86485	1.00212	1.00212	1.02470	1.08908	2.44%
1994	25.52%	35.25%	39.23%	1.38602	1.29144	0.82652	0.98733	0.98892	0.99889	1.08787	-0.11%
1995	23.68%	36.63%	39.69%	1.38602	1.32167	0.83296	1.01518	1.01523	1.01145	1.10033	1.14%
1996	23.08%	34.63%	42.29%	1.45673	1.36140	0.90869	1.06171	1.06265	1.05956	1.16586	5.79%
1997	23.69%	34.65%	41.65%	1.53104	1.39550	0.87934	0.99352	0.99293	1.00645	1.17338	0.64%

## **APPENDIX B**

### **ORIGINAL FCC MODEL**

**1985-1995**

**Chart D1: Components of FCC LEC Price Cap X-Factor [Excluding CPD]**

Year	Input Price Growth Rates			Total Factor Productivity Growth Rates			LEC
	Total RBOCs	U.S. Nonfarm Business Sector	Differential	Total RBOCs	U.S. Nonfarm Business Sector	Differential	Price/Productivity Differential
	A	B	C=B-A	D	E	F=D-E	G=C+F
1984							
1985							
1986	4.94%	2.81%	-2.13%	2.58%	0.92%	1.66%	-0.47%
1987	0.56%	2.53%	1.97%	2.97%	-0.02%	2.99%	4.96%
1988	-1.58%	3.73%	5.31%	0.12%	0.46%	-0.34%	4.97%
1989	-2.36%	3.04%	5.40%	1.94%	-0.55%	2.49%	7.89%
1990	1.88%	3.31%	1.43%	6.85%	-0.47%	7.32%	8.76%
1991	-0.85%	2.06%	2.91%	2.03%	-0.89%	2.92%	5.83%
1992	2.68%	2.88%	0.20%	4.32%	1.10%	3.22%	3.42%
1993	2.27%	3.72%	1.45%	3.80%	0.55%	3.25%	4.70%
1994	-0.19%	3.50%	3.69%	2.21%	0.50%	1.71%	5.40%
1995	1.32%	3.09%	1.77%	5.20%	0.16%	5.04%	6.81%
<b>Averages</b>							
[1986-94]	0.82%	3.06%	2.25%	2.98%	0.18%	2.80%	5.05%
[1986-95]	0.87%	3.07%	2.20%	3.20%	0.18%	3.03%	5.23%
[1987-95]	0.41%	3.10%	2.68%	3.27%	0.09%	3.18%	5.86%
[1988-95]	0.39%	3.17%	2.77%	3.31%	0.11%	3.20%	5.97%
[1989-95]	0.68%	3.09%	2.41%	3.77%	0.06%	3.71%	6.12%
[1990-95]	1.18%	3.09%	1.91%	4.07%	0.16%	3.91%	5.82%
[1991-95]	1.04%	3.05%	2.01%	3.51%	0.28%	3.23%	5.23%

**Chart D2: RBOC Interstate Revenues**

Year	End User A	Interstate Switched Access B	Special Access C	Total Interstate D = A + B + C
1984				
1985	\$1,499,413,893	\$10,906,203,190	\$1,960,688,644	\$14,366,305,727
1986	\$2,400,475,814	\$10,484,265,170	\$2,574,800,716	\$15,459,541,700
1987	\$3,090,639,929	\$9,611,996,187	\$2,657,677,439	\$15,360,313,555
1988	\$3,604,221,000	\$9,662,529,000	\$2,539,698,000	\$15,806,448,000
1989	\$4,398,692,000	\$9,092,575,000	\$2,253,922,000	\$15,745,189,000
1990	\$4,679,142,000	\$8,595,750,000	\$2,209,064,000	\$15,483,956,000
1991	\$4,828,177,000	\$8,514,130,000	\$2,119,037,000	\$15,461,344,000
1992	\$4,963,262,000	\$8,650,880,000	\$2,153,565,000	\$15,767,707,000
1993	\$5,244,094,000	\$8,999,065,000	\$2,097,997,000	\$16,341,156,000
1994	\$5,589,662,000	\$9,293,783,000	\$2,217,125,000	\$17,100,570,000
1995	\$5,770,285,000	\$9,332,869,000	\$2,529,667,000	\$17,632,821,000

**Chart D3: RBOC REVENUES (Excluding Miscellaneous Services)**

Year	Local Service	Intrastate Toll and Intrastate Access	Interstate	Total
	A	B	C	D = A + B + C
1984				
1985	\$26,960,554,164	\$13,047,095,682	\$14,366,305,727	\$54,373,955,573
1986	\$28,626,174,049	\$13,538,946,795	\$15,459,541,700	\$57,624,662,544
1987	\$29,150,842,991	\$14,166,723,124	\$15,360,313,555	\$58,677,879,670
1988	\$29,226,988,000	\$14,994,975,000	\$15,806,448,000	\$60,028,411,000
1989	\$29,973,157,000	\$14,868,219,000	\$15,745,189,000	\$60,586,565,000
1990	\$30,699,085,000	\$15,014,729,000	\$15,483,956,000	\$61,197,770,000
1991	\$32,059,008,000	\$14,522,276,000	\$15,461,344,000	\$62,042,628,000
1992	\$33,359,990,000	\$14,225,181,000	\$15,767,707,000	\$63,352,878,000
1993	\$34,598,957,000	\$14,496,831,000	\$16,341,156,000	\$65,436,944,000
1994	\$35,758,637,000	\$14,355,983,000	\$17,100,570,000	\$67,215,190,000
1995	\$37,684,860,000	\$13,123,225,000	\$17,632,821,000	\$68,440,906,000

Chart D4: Calculation of Fisher Ideal Index for Interstate Output

Year	Revenue Shares			Quantities			Output Indices			Interstate Output Quantity Index	Growth
	End User	Interstate Switched Access	Special Access	Access Lines	Switched Access Minutes	Special Access Lines	Laspeyres A	Paasche B	Fisher Relative $C=(A*B)^{0.5}$		
1984											
1985	10.44%	75.92%	13.65%	92,671,959	156,853,820,000	1,230,590	1.000000	1.000000	1.000000	1.000000	
1986	15.53%	67.82%	16.66%	95,333,884	157,302,701,000	1,664,101	1.053249	1.052253	1.052751	1.052751	5.14%
1987	20.12%	62.58%	17.30%	98,228,585	173,154,171,000	1,764,445	1.083098	1.078813	1.080953	1.137975	7.78%
1988	22.80%	61.13%	16.07%	98,270,787	187,663,836,000	2,701,817	1.144443	1.114960	1.129605	1.285462	12.19%
1989	27.94%	57.75%	14.31%	101,190,050	210,406,134,000	2,448,090	1.065768	1.058920	1.062338	1.365595	6.05%
1990	30.22%	55.51%	14.27%	103,857,988	231,960,296,000	3,518,005	1.129086	1.114500	1.121769	1.531882	11.49%
1991	31.23%	55.07%	13.71%	107,383,807	246,710,182,000	5,151,699	1.111811	1.094856	1.103301	1.690127	9.83%
1992	31.48%	54.86%	13.66%	108,938,065	262,187,655,000	6,033,139	1.082516	1.060258	1.061386	1.793878	5.98%
1993	32.09%	55.07%	12.84%	112,196,681	278,173,161,000	10,153,615	1.136148	1.102619	1.119258	2.007812	11.27%
1994	32.69%	54.35%	12.97%	115,264,861	298,342,017,323	13,824,385	1.095119	1.086800	1.090952	2.190425	8.71%
1995	32.72%	52.93%	14.35%	119,887,506	334,981,582,000	16,107,677	1.101268	1.099925	1.100596	2.410774	9.59%
Average[1986-95]											8.80%



Chart D5: Calculation of Fisher Ideal Index for Total Company Output

Year	Revenue Shares			Quantities			Output Indices			Total Company Output Index	Growth
	Local Service	Intrastate Toll and Intrastate Access	Interstate	Number of Local Calls	Intrastate DEMs	Interstate Quantity Index	Laspeyres	Paasche	Fisher Relative		
		A					B	C	A		
1984											
1985	49.58%	24.00%	26.42%	310,696,999,600	164,191,177,000	1.000000	1.000000	1.000000	1.000000	1.000000	
1986	49.68%	23.50%	26.83%	315,839,746,231	173,173,536,000	1.052751	1.035272	1.034895	1.035083	1.035083	3.45%
1987	49.68%	24.14%	26.18%	320,735,770,416	183,597,411,000	1.137975	1.043561	1.042639	1.043100	1.079696	4.22%
1988	48.69%	24.98%	26.33%	318,724,184,964	191,904,837,000	1.285462	1.041736	1.039449	1.040592	1.123522	3.98%
1989	49.47%	24.54%	25.99%	330,212,044,704	207,298,177,000	1.365595	1.054001	1.053389	1.053695	1.183850	5.23%
1990	50.16%	24.53%	25.30%	342,403,840,684	217,913,904,000	1.531882	1.062478	1.060759	1.061618	1.256797	5.98%
1991	51.67%	23.41%	24.92%	353,219,571,000	219,713,721,000	1.690127	1.044009	1.042832	1.043420	1.311367	4.25%
1992	52.66%	22.45%	24.89%	365,468,629,000	224,278,538,000	1.793878	1.038080	1.038005	1.038042	1.361254	3.73%
1993	52.87%	22.15%	24.97%	376,995,406,000	227,540,869,000	2.007812	1.049556	1.048164	1.048860	1.427765	4.77%
1994	53.20%	21.36%	25.44%	392,601,075,000	235,362,364,000	2.190425	1.052215	1.052028	1.052121	1.502182	5.08%
1995	55.06%	19.17%	25.76%	409,383,799,000	246,926,539,000	2.410774	1.058829	1.058314	1.058572	1.590167	5.69%
Average(1986-95)											4.64%



**Chart D7: Summary of Capital Adjustments and Average Depreciation**

Year	TPIS.BOY A	Unadj. Additions B	TPIS.EOY C	Retires D=A+B-C	Adjustment Factor E	Adjusted Additions F = B * E	Adjusted EOY TPIS G = A+F-D	Depreciation Accruals H	Adjusted Depreciation Rate I=H/((A+G)/2)
1984									
1985	138,879,365	15,001,998	149,061,793	4,819,569	0.8880	13,321,774	147,381,569	10,241,376	7.155%
1986	149,061,793	14,842,725	159,010,189	4,894,328	0.8880	13,180,340	157,347,804	11,826,961	7.720%
1987	159,010,189	14,138,370	167,720,577	5,427,983	0.8880	12,554,872	166,137,079	13,311,655	8.188%
1988	168,505,114	14,284,742	175,860,216	6,929,640	1.0000	14,284,742	175,860,216	13,134,992	7.629%
1989	175,860,216	13,283,569	182,978,381	6,165,404	1.0000	13,283,569	182,978,381	13,420,810	7.480%
1990	182,978,381	14,476,334	187,168,695	10,286,020	1.0000	14,476,334	187,168,695	13,439,933	7.262%
1991	187,168,695	14,527,049	192,034,545	9,661,199	1.0000	14,527,049	192,034,545	13,200,593	6.962%
1992	192,034,545	14,611,866	196,411,915	10,234,496	1.0000	14,611,866	196,411,915	13,337,581	6.867%
1993	196,411,915	14,860,116	203,082,418	8,189,613	1.0000	14,860,116	203,082,418	14,032,782	7.025%
1994	203,082,418	14,717,999	209,325,562	8,474,855	1.0000	14,717,999	209,325,562	14,863,196	7.208%
1995	209,325,562	15,374,568	217,430,207	7,269,923	1.0000	15,374,568	217,430,207	15,358,553	7.198%
Average[1985-95]									7.336%



Chart D9: Capital Quantity and Price Index Calculations

Year	Benchmark A	Adjusted Capital Additions B	BEA Composite Asset Price C	Capital Stock Quantity D	Capital Input Quantity E	Capital Input Quantity Growth F	Property Income /w Depreciation G	Capital Rental Price** H	Capital Rental Price Index I	Rental Price Index Growth J
1984		n/a		103,903,095						
1985	109,602,959	13,321,774	1.000000	109,602,710	1.000000		23,445,593,794	0.225648657	1.000000	
1986		13,180,340	1.013181	114,571,307	1.054855	0.053403	26,792,578,943	0.244451792	1.083329	8.00%
1987		12,554,872	1.030871	118,345,444	1.102675	0.044335	27,701,751,800	0.24178612	1.071516	-1.10%
1988		14,284,742	1.035999	123,452,193	1.138998	0.032410	26,866,209,000	0.227015153	1.006056	-6.30%
1989		13,283,569	1.075241	126,749,984	1.188147	0.042246	25,845,853,000	0.209359205	0.927811	-8.10%
1990		14,476,334	1.092233	130,705,704	1.219887	0.026363	25,584,541,000	0.201850448	0.894534	-3.65%
1991		14,527,049	1.106013	134,251,960	1.257958	0.030732	24,641,357,000	0.188525491	0.835482	-6.83%
1992		14,611,866	1.111942	137,544,312	1.292088	0.026770	26,477,135,000	0.197219728	0.874012	4.51%
1993		14,860,116	1.123482	140,681,129	1.323775	0.024228	26,914,823,000	0.195681106	0.867194	-0.78%
1994		14,717,999	1.140461	143,266,301	1.353965	0.022550	26,366,385,000	0.187419487	0.830581	-4.31%
1995		15,374,568	1.150848	146,115,862	1.378845	0.018209	27,166,096,000	0.189619581	0.840331	1.17%

Column C from Capital Price Index Workbook

**Chart D10: Factor Shares of Total Payments**

Year	Labor Compensation	Materials Payment	Property Income /w Depreciation	Total Factor Payment	Labor Compensation Share	Materials Payment Share	Property Income /w Depreciation Share
1984							
1985	16,991,572,326	13,936,789,453	23,445,593,794	54,373,955,573	31.25%	25.63%	43.12%
1986	16,728,435,454	14,103,648,147	26,792,578,943	57,624,662,544	29.03%	24.48%	46.49%
1987	16,978,905,847	13,997,222,023	27,701,751,800	58,677,879,670	28.94%	23.85%	47.21%
1988	17,030,359,791	16,131,842,209	26,866,209,000	60,028,411,000	28.37%	26.87%	44.76%
1989	16,910,850,694	17,829,861,306	25,845,853,000	60,586,565,000	27.91%	29.43%	42.66%
1990	17,586,868,921	18,026,360,079	25,584,541,000	61,197,770,000	28.74%	29.46%	41.81%
1991	17,186,211,200	20,215,059,800	24,641,357,000	62,042,628,000	27.70%	32.58%	39.72%
1992	17,160,988,000	19,714,755,000	26,477,135,000	63,352,878,000	27.09%	31.12%	41.79%
1993	17,956,438,000	20,565,683,000	26,914,823,000	65,436,944,000	27.44%	31.43%	41.13%
1994	17,154,284,000	23,694,521,000	26,366,385,000	67,215,190,000	25.52%	35.25%	39.23%
1995	16,203,522,000	25,071,288,000	27,166,096,000	68,440,906,000	23.68%	36.63%	39.69%

Chart D11: Input Quantity Index

Year	Shares			Quantities			Quantity Indexes				Growth
	Labor	Materials	Property	Labor	Materials	Capital	Laspeyers	Paasche	Fisher	Fisher	
	Compensation	Payment	Income /w Depreciation				A	B	Relative C=(A*B)^0.5	Chain	
1984											
1985	31.25%	25.63%	43.12%	504,113	13,936,789,453	1.00000	1.00000	1.00000	1.00000	1.00000	
1986	29.03%	24.48%	46.49%	482,698	13,816,269,736	1.05486	0.97277	0.97270	1.00871	1.00871	0.87%
1987	28.94%	23.85%	47.21%	477,714	13,518,661,409	1.10267	0.98454	0.98458	1.01258	1.02140	1.25%
1988	28.37%	26.87%	44.76%	466,827	15,233,089,905	1.13900	1.04481	1.04468	1.03930	1.06154	3.85%
1989	27.91%	29.43%	42.66%	461,149	16,231,098,139	1.18815	1.02562	1.02623	1.03343	1.09702	3.29%
1990	28.74%	29.46%	41.81%	443,105	15,765,576,420	1.21989	0.96623	0.96613	0.99130	1.08748	-0.87%
1991	27.70%	32.58%	39.72%	414,457	17,288,172,240	1.25796	1.01696	1.01609	1.02248	1.11192	2.22%
1992	27.09%	31.12%	41.79%	411,167	16,514,286,313	1.29209	0.97216	0.97203	0.99416	1.10543	-0.59%
1993	27.44%	31.43%	41.13%	395,639	17,057,048,188	1.32377	1.00000	0.99869	1.00970	1.11615	0.97%
1994	25.52%	35.25%	39.23%	367,196	19,198,283,098	1.35396	1.03351	1.03324	1.02911	1.14865	2.87%
1995	23.68%	36.63%	39.69%	346,843	19,836,449,086	1.37885	0.99600	0.99652	1.00493	1.15431	0.49%

Chart D12: Input Price Index

Year	Shares			Quantities			Quantity Indexes				Growth
	Labor	Materials	Property	Labor	Materials	Capital	Laspeyers	Paasche	Fisher	Fisher	
	Compensation	Payment	Income /w Depreciation				A	B	Relative C=(A*B)^0.5	Chain	
1984											
1985	31.25%	25.63%	43.12%	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	
1986	29.03%	24.48%	46.49%	1.02819	1.02080	1.08333	1.06002	1.06092	1.05064	1.05064	4.94%
1987	28.94%	23.85%	47.21%	1.05447	1.03540	1.07152	0.99779	0.99742	1.00563	1.05655	0.56%
1988	28.37%	26.87%	44.76%	1.08234	1.05900	1.00606	0.96707	0.96872	0.98433	1.03999	-1.58%
1989	27.91%	29.43%	42.66%	1.08797	1.09850	0.92781	0.96540	0.96597	0.97665	1.01571	-2.36%
1990	28.74%	29.46%	41.81%	1.17754	1.14340	0.89453	0.99546	0.99444	1.01895	1.03496	1.88%
1991	27.70%	32.58%	39.72%	1.23025	1.16930	0.83548	0.97064	0.97196	0.99152	1.02618	-0.85%
1992	27.09%	31.12%	41.79%	1.23828	1.19380	0.87401	1.03478	1.03523	1.02712	1.05401	2.68%
1993	27.44%	31.43%	41.13%	1.34653	1.20570	0.86719	0.99978	0.99982	1.02297	1.07822	2.27%
1994	25.52%	35.25%	39.23%	1.38602	1.23420	0.83058	0.98631	0.98786	0.99812	1.07619	-0.19%
1995	23.68%	36.63%	39.69%	1.38602	1.26390	0.84033	1.01757	1.01762	1.01324	1.09044	1.32%





**Chart D1: Components of FCC LEC Price Cap X-Factor [Excluding CPD]**

Year	Input Price Growth Rates			Total Factor Productivity Growth Rates			LEC
	Total	U.S. Nonfarm	Differential	Total	U.S. Nonfarm	Differential	Price/Productivity
	RBOCs A	Business Sector B	C=B-A	RBOCs D	Business Sector E	F=D-E	Differential G=C+F
1984							
1985							
1986	4.94%	2.33%	-2.61%	2.58%	1.10%	1.48%	-1.13%
1987	0.56%	3.45%	2.89%	2.97%	-0.50%	3.47%	6.36%
1988	-1.58%	5.02%	6.60%	0.12%	0.30%	-0.18%	6.42%
1989	-2.36%	2.42%	4.78%	1.94%	0.20%	1.74%	6.52%
1990	1.88%	3.31%	1.43%	6.85%	-0.70%	7.55%	8.99%
1991	-0.85%	1.77%	2.62%	2.03%	-1.41%	3.44%	6.06%
1992	2.68%	3.15%	0.47%	4.32%	1.71%	2.61%	3.08%
1993	2.27%	2.18%	-0.09%	3.80%	0.20%	3.60%	3.51%
1994	-0.19%	3.37%	3.56%	2.21%	0.30%	1.91%	5.47%
1995	1.32%	2.61%	1.30%	5.20%	-0.20%	5.40%	6.70%
<b>Averages</b>							
[1986-94]	0.82%	3.00%	2.18%	2.98%	0.13%	2.85%	5.03%
[1986-95]	0.87%	2.96%	2.09%	3.20%	0.10%	3.10%	5.20%
[1987-95]	0.41%	3.03%	2.62%	3.27%	-0.01%	3.28%	5.90%
[1988-95]	0.39%	2.98%	2.58%	3.31%	0.05%	3.26%	5.84%
[1989-95]	0.68%	2.69%	2.01%	3.77%	0.01%	3.75%	5.76%
[1990-95]	1.18%	2.73%	1.55%	4.07%	-0.02%	4.09%	5.63%
[1991-95]	1.04%	2.62%	1.57%	3.51%	0.12%	3.39%	4.96%

## APPENDIX D

### MODIFIED FCC MODEL (REVISED MATERIALS PRICE INDEX) 1985-1995



## APPENDIX E

### ORIGINAL FCC MODEL (REVISED BEA COMPOSITE ASSET PRICE) 1985-1995

**Chart D1: Components of FCC LEC Price Cap X-Factor [Excluding CPD]**

Year	Input Price Growth Rates			Total Factor Productivity Growth Rates			LEC
	Total RBOCs	U.S. Nonfarm Business Sector	Differential	Total RBOCs	U.S. Nonfarm Business Sector	Differential	Price/Productivity Differential
	A	B	C=B-A	D	E	F=D-E	G=C+F
1984							
1985							
1986	4.94%	2.81%	-2.13%	2.58%	0.92%	1.66%	-0.47%
1987	0.60%	2.53%	1.93%	3.00%	-0.02%	3.02%	4.96%
1988	-1.52%	3.73%	5.25%	0.18%	0.46%	-0.28%	4.97%
1989	-2.33%	3.04%	5.37%	1.97%	-0.55%	2.52%	7.89%
1990	1.82%	3.31%	1.49%	6.79%	-0.47%	7.26%	8.76%
1991	-0.92%	2.06%	2.98%	1.96%	-0.89%	2.85%	5.83%
1992	2.62%	2.88%	0.26%	4.26%	1.10%	3.16%	3.42%
1993	2.23%	3.72%	1.49%	3.77%	0.55%	3.22%	4.70%
1994	-0.28%	3.50%	3.78%	2.12%	0.50%	1.62%	5.40%
1995	1.16%	3.09%	1.93%	5.05%	0.16%	4.89%	6.81%
<b>Averages</b>							
[1986-94]	0.79%	3.06%	2.27%	2.96%	0.18%	2.78%	5.05%
[1986-95]	0.83%	3.07%	2.24%	3.17%	0.18%	2.99%	5.23%
[1987-95]	0.38%	3.10%	2.72%	3.23%	0.09%	3.14%	5.86%
[1988-95]	0.35%	3.17%	2.82%	3.26%	0.11%	3.16%	5.97%
[1989-95]	0.61%	3.09%	2.47%	3.70%	0.06%	3.65%	6.12%
[1990-95]	1.11%	3.09%	1.99%	3.99%	0.16%	3.83%	5.82%
[1991-95]	0.96%	3.05%	2.09%	3.43%	0.28%	3.15%	5.23%

4. [Download the source code](#)







FCC STAFF'S PRODUCTIVITY MODEL (6.5% X-factor basis)  
 1996-97 BOC Industry DATA UPDATE

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FCC CHART D7	FCC Model	UPDATE	UPDATE
	1995	1996	1997
TPIS - BOY	\$209,325,562	\$217,430,207	\$227,317,120
SOCC, Tab 2.7 (Ac260-2111)	3.07%	3.87%	4.55%
Unadj. Additions	\$15,374,568	\$18,026,150	\$18,253,199
SOCC, Tab 2.7 (Ac260-2111)	4.46%	17.25%	1.26%
TPIS - EOY	\$217,430,207	\$227,317,120	\$236,896,179
SOCC, Tab 2.7 (Ac260-2111)	3.87%	4.55%	4.21%
<i>Retires = BOY+Addds-EOY</i>	\$7,269,923	\$8,139,237	\$8,674,140
Depreciation Accruals	\$15,358,553	\$16,252,281	\$16,667,034
SOCC Tabl 2.9, I 250+252	3.33%	5.82%	2.55%

FCC STAFF'S PRODUCTIVITY MODEL (6.5% X-factor basis)  
 1996-97 BOC Industry DATA UPDATE

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FCC CHART D8	FCC Model	UPDATE	UPDATE
	1995	1996	1997
Operating Expense SOCC Tabl 2.9, line 280	\$56,831,094 1.63%	\$57,884,494 1.85%	\$59,731,175 3.19%
Depreciation & Amortiz. SOCC Tabl 2.9, line 255	\$15,556,284 3.24%	\$16,377,242 5.28%	\$16,758,832 2.33%
Employee Compensation Stat of C. C. Table 2.9, line 324	\$16,203,522 -5.54%	\$18,457,448 13.91%	\$17,451,673 -5.45%
Materials = OpExp-Dep-Comp calc	\$25,071,288 5.81%	\$23,049,804 -8.06%	\$25,520,670 10.72%

**USTA 1996/97 UPDATE OF FCC PRODUCTIVITY MODEL**  
**MODEL DATA ADJUSTMENTS TO REPORTED BOC INDUSTRY DATA**

Item	YEAR	Model Exhibit	Data Item	BOC Total REPORTED	BOC Total REVISION/Estimate	% CHG	EXPLANATION
1	1996	D5	Intrastate DEMs	Not released	258,038,233,255	4.50% over '95	Estimate, pending release of latest Joint Board Monitoring Report
2	1996	D4	Switch Acc Minutes	Not released	362,159,903,714	8.11% over '95	Estimate, pending Joint Board publication Used growth rates for Interstate interlata billed access minutes from Table 2.10, Stat. Of Comm. Common Carriers
3	1996	D6	Labor Compensation	\$18,457,448,000	16,597,889,075	-10.07%	Normalized value substituted to reflect change in reporting basis after FCC clarification to include benefits \$
1	1997	D5	Intrastate DEMs	Not released	269,649,953,751	4.50% over '96	Estimate, pending release of latest Joint Board Monitoring Report
2	1997	D4	Switch Acc Minutes	Not released	387,587,696,669	7.02% over '96	Estimate, pending Joint Board publication Used growth rates for Interstate interlata billed access minutes from Table 2.10, Stat. Of Comm. Common Carriers
3	1997	D5	Local Calls (000)	408,389,023,000	433,086,737,000	6.05%	Revision to New York Tel.
4	1997	D4	Special Acc Lines	27,891,558	24,479,958	-12.23%	Revision to US West Revision to New York Tel.

**Review of USTA TFPRP Model**  
**Statement of Professor Frank M. Gollop**  
**Boston College**  
**October 22, 1998**

I have been asked by USTA to review its TFPRP model to audit the economic and spreadsheet logic of the model and to determine whether the model has been appropriately updated through 1997. I have completed that task. My overall assessment is that USTA's TFPRP model is internally consistent, defines TFP growth in an economically meaningful and consistent way, and properly updates its code to apply to both 1996 and 1997.

The program is initialized with (a) company-specific data for LECs and (b) a set of data of economy-wide price and TFP data for the U.S. economy. I have not audited the primary LEC data and so offer no opinion on their validity. However, I prepared the updated U.S. economy data for 1996 and 1997 for the USTA model and have determined that the updated economy-wide data are properly linked to the earlier series ending in 1995. I have also determined that the company data are properly summed to form industry totals for the industry-level analysis.

The spreadsheet logic is not only internally consistent but also applies a standard model of TFP accounting. Growth rates of price and quantity data entering into any calculation leading ultimately to the measurement of TFP or the X-Factor are consistently defined in logarithms. When aggregate growth rates are formed, arithmetic averages of the appropriate cost or revenue shares are applied. This is the standard Tornquist indexing technique. It is applied to the measurement of industry output, inputs, and TFP. All spreadsheet commands introduced for both 1996 and 1997 are proper extensions of formulas applied in earlier years. The updated data are treated identically to those for earlier years.

My overall assessment is that the updated USTA TFPRP model contains no spreadsheet coding errors. Moreover, its design and results are consistent with standard TFP accounting practice.

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**ACADEMIC APPOINTMENTS:**

Professor of Economics, Boston College, 1985-Present

Associate Professor of Economics, Boston College, 1979-1985.

Assistant Professor of Economics, University of Wisconsin-Madison, 1974-1979.

**GRADUATE STUDIES:**

Harvard University: A.M., November 1972; Ph.D., July 1974

Ph.D. Thesis: Modeling Technical Change and Market Imperfections: An Econometric Analysis of U.S. Manufacturing, 1947-1971.

**UNDERGRADUATE STUDIES:**

University of Santa Clara:     A.B. in Economics, June 1969;  
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Economic Classification Policy Committee, Expert Consultant to U.S. Government, 1992-Present.

**HONORS, AWARDS and GRANTS:**

U.S. Department of Agriculture Grant 1995-98  
National Science Foundation Grant, 1992-94  
U.S. Department of Agriculture Grant 1992-97  
U.S. Bureau of the Census Grant, 1985-87  
U.S. Bureau of the Census Grant, 1984-86  
Federal Trade Commission Grant, 1984  
Research Fellowship, Boston College, 1984  
Summer Research Grant, Boston College, 1983  
U.S. Bureau of the Census Grant, 1983  
U.S. Bureau of the Census Grant, 1982  
U.S. Department of Commerce Grant, 1982  
Center for Economic Development Grant, 1982  
Federal Energy Regulatory Commission Grant, 1980  
U.S. Department of Labor Grant, 1979-1980  
U.S. Department of Commerce Grant, 1978-1979

Graduate School Research Committee Grant, Univ. of Wisconsin, 1979  
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 Graduate School Research Committee Grant, Univ. of Wisconsin, 1978  
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 Department Fellow, Harvard University, 1971-1972  
 University Fellowship, University of Santa Clara, 1965-1969

#### PROFESSIONAL SOCIETIES:

American Economic Association  
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 Eastern Economic Association  
 Western Economic Association

#### RECENT REFEREEING ACTIVITY:

American Economic Review, National Science Foundation, Review of Economics and Statistics, Land Economics, Southern Economic Journal, The Canadian Journal of Economics, Journal of Environmental Economics and Management, Review of Industrial Organization, American Journal of Agricultural Economics.

#### PUBLICATIONS:

"Structural Inflation in the United States, 1964-1966," The American Economist, 13, No. 2 (Fall 1969), pp. 31-39.

"The Impact of the Fuel Adjustment Mechanism on Economic The Review of Economics and Statistics, 60, No. 4 (November 1978), pp. 574-84 (with Stephen Karlson).

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"Accounting for Intermediate Input: The Link Between Sectoral and Aggregate Measures of Productivity Growth," in A. Rees and J. Kendrick (eds.), The Measurement and Interpretation of Productivity. Washington, D.C.: National Academy of Sciences, 1979.

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"The Sources of Growth in the U.S. Electric Power Industry," in T. Cowing and R. Stevenson (eds.), Productivity Measurement in Regulated Industries. New York: Academic Press, 1980 (with Mark Roberts).

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"Environmental and Health/Safety Regulations, Productivity Growth, and Economic Performance: An Assessment," U.S. Congress, Joint Economic Committee and Senate Commerce Committee, Committee Print, Washington, D.C.: Government Printing Office, 1980 (with Greg Christiansen and Robert Haveman).

"Scale Effects and Technical Change as Sources of Productivity Growth," in John D. Hogan (ed.), Dimensions of Productivity Research. Houston: American Productivity Center, 1980.

"A Microeconomic Model of Household Choice: The Household as a Disputant," Law & Society Review, 15: 3-4 (1980-81), pp. 611-630, (with Jeffrey Marquandt).

"Automatic Adjustment Clauses: The Effect on Fuel Prices," in U.S. Department of Energy, Federal Energy Regulatory Commission, Automatic Adjustment Clauses in Public Utility Rate Schedules. Washington, D.C.: Government Printing Office, 1982 (with Stephen Karlson).

"The Economic Consequences of Automatic Adjustment Clauses," in U.S. Department of Energy, Federal Energy Regulatory Commission, Automatic Adjustment Clauses in Public Utility Rate Schedules. Washington, D.C.: Government Printing Office, 1982 (with Stephen Karlson).

"Growth Accounting in an Open Economy," in A. Dogramici (ed.), Developments in Econometric Analyses of Productivity. Boston: Klumer Nijhoff, 1982.

"Development and Use of the Longitudinal Establishment Data File," in U.S. Bureau of the Census, Workshop on the Development and Use of Longitudinal Establishment Data. Washington, D.C.: U.S. Government Printing Office, 1982.

"Sectoral Measures of Labor Cost for the United States, 1948-1978," in J.E. Triplett (ed.), The Measurement of Labor Cost, Studies in Income and Wealth, Vol. 48, Chicago: University of Chicago Press for the NBER, 1983 (with Dale Jorgenson).

"Environmental Regulations and Productivity Growth: The Case of Fossil-Fueled Electric Power Generation," Journal of Political Economy, 91 (August 1983), pp. 654-74 (with Mark Roberts).

"Cost-Minimizing Regulation of Sulfur Emissions: Regional Gains in Electric Power," The Review of Economics and Statistics, 67 (February 1985), pp. 81-90, (with Mark Roberts).

"Productivity and Growth of Sectoral Output in the United States, 1948-1979," in J.W. Kendrick (ed.), Interindustry Differences in Productivity Growth. Cambridge: Ballinger Press, 1985, (with Dale Jorgenson and Barbara Fraumeni).

"Analysis of the Productivity Slowdown: Evidence for a Sector-Biased or Sector-Neutral Industrial Strategy," in W. Baumol and K. McLennan (eds.), Productivity Growth and U.S. Competitiveness. New York: Oxford University Press, 1985.

"Cost Minimizing Regulation of Sulfur Emissions: A Summary," Regulation, 9 (Nov./Dec. 1985), pp. 51-2 (with Mark Roberts).



"The Effect of Warranty on Used Car Prices," in Pauline Ippolito and David Sheffman (eds.), Empirical Approaches to Consumer Protection Economics, Washington, D.C.: Federal Trade Commission, 1986 (with Jim Anderson).

"Evaluating SIC Boundaries and Industry Change over Time: An Index of Establishment Heterogeneity," Bureau of the Census, Second Annual Research Conference Proceedings, Washington, D.C.: Bureau of the Census, 1986.

"Modeling Aggregate Productivity Growth: The Importance of Intersectoral Transfer Prices and International Trade," Review of Income and Wealth, (1987), pp. 211-27.

Productivity and U.S. Economic Growth. Cambridge: Harvard University Press, 1987 (with Dale Jorgenson and Barbara Fraumeni).

From Homogeneity to Heterogeneity: An Index of Diversification. U.S. Bureau of the Census, Technical Paper 60. Washington, D.C.: U.S. Government Printing Office, 1989 (with Jim Monahan).

Comments on "Regulatory Failure, Regulatory Reform, and Structural Change in the Electric Power Industry" by P. Joskow in M. Bailey and C. Winston (eds.), <

"Total Resource Productivity: Accounting for Changing Environmental Quality," in Edwin Dean, Michael Harper, and Charles Hulten (eds.), New Developments in Productivity Analysis, Conference on Research in Income and Wealth, forthcoming, (with G. Swinand).

**UNPUBLISHED PAPERS: (\* = submitted for publication)**

"Entrepreneurial Income: A Noncompetitive Return to Labor and Capital," Bureau of Labor Statistics Working Paper (June 1977), 20 pp.

"A Behavioral Model of Production: Oligopolistic Markets," Social Systems Research Institute Workshop Paper 7811 (April 1978), 27 pp. (with Mark Roberts).

"An Intertemporal Model of Behavior: The Regulated Monopolist," Social Systems Research Institute Workshop Paper 7812 (May 1978), 24 pp. (with Stephen Karl







